Fermi National Accelerator Laboratory

FERMILAB Conf-94/222-E
CDF

Search for New Particles Decaying to Dijets in $p\bar{p}$ Collisions at $\sqrt{s}$ = 1.8 TeV

Robert M. Harris
The CDF Collaboration

Fermi National Accelerator Laboratory
P.O. Box 500, Batavia, Illinois 60510

August 1994

Published Proceedings of the *Eighth Meeting of the Division of Particles and Fields of the American Physical Society (DPF'94)*, Albuquerque, NM, August 2-6, 1994.

Operated by Universities Research Association Inc. under Contract No. DE-AC02-76CHO3000 with the United States Department of Energy

Disclaimer

CDF/PUB/EXOTIC/PUBLIC/2714
FERMILAB-CONF-94/222-E

Search for New Particles Decaying to Dijets in $p\bar{p}$ collisions at $\sqrt{s} = 1.8$ TeV

The CDF Collaboration

Presented by
Robert M. Harris
Fermilab, Batavia, IL 60510

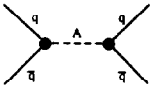
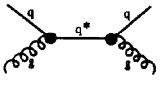
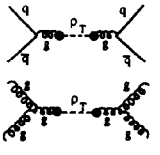
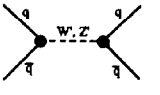
ABSTRACT

We present a preliminary search for new particles decaying to dijets using CDF data from the 1992-3 run. We set the highest mass limits on axigluons and excited quarks, and the first mass limit on a color octet technirho.

1. Introduction

Many classes of new particles have large branching fractions into just two partons (quarks and gluons) which appear as dijets. Here we conduct a general search for particles with a narrow natural width, concentrating on those in Fig 1a: axigluons from chiral QCD ($A \to q\bar{q}$), excited states of composite quarks ($q^* \to qg$), color octet technirhos ($\rho_T \to g \to q\bar{q}, gg$), and new gauge bosons ($W', Z' \to q\bar{q}$).

a) New Particles that Decay to Dijets

Model	Particle	Production/Decay	$\Gamma/2$	$\sigma \cdot B$(500 GeV)
Chiral Color $SU(3)_L \times SU(3)_R$	Axigluon A		.05M	210 pb
Composite Fermions	Excited Quark q^*		.02M	40 pb
Technicolor	Technirho ρ_T		.01M	13 pb
Extended Gauge Models.	New Gauge Bosons W', Z'		.01M	5 pb, 4 pb

b) Excited Quark Search ($q^* \to qg$)

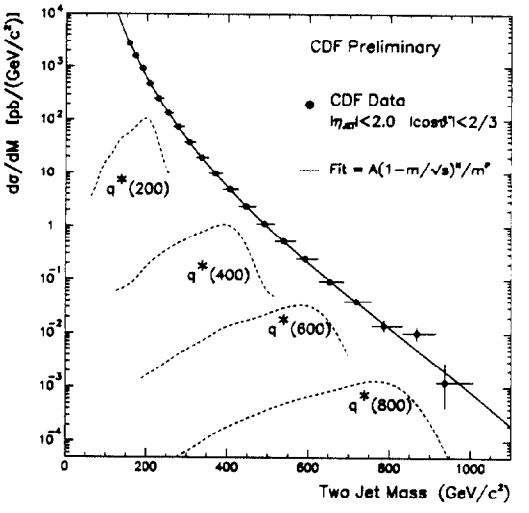


Fig. 1. **a)** New particle models, diagrams, widths and cross sections. **b)** Dijet mass data, background fit, and mass resonance line shape (q*).

Published Proceedings Eighth Meeting of the Division of Particles and Fields of the American Physical Society (DPF'94), University of New Mexico, Albuquerque, NM, August 2-6, 1994

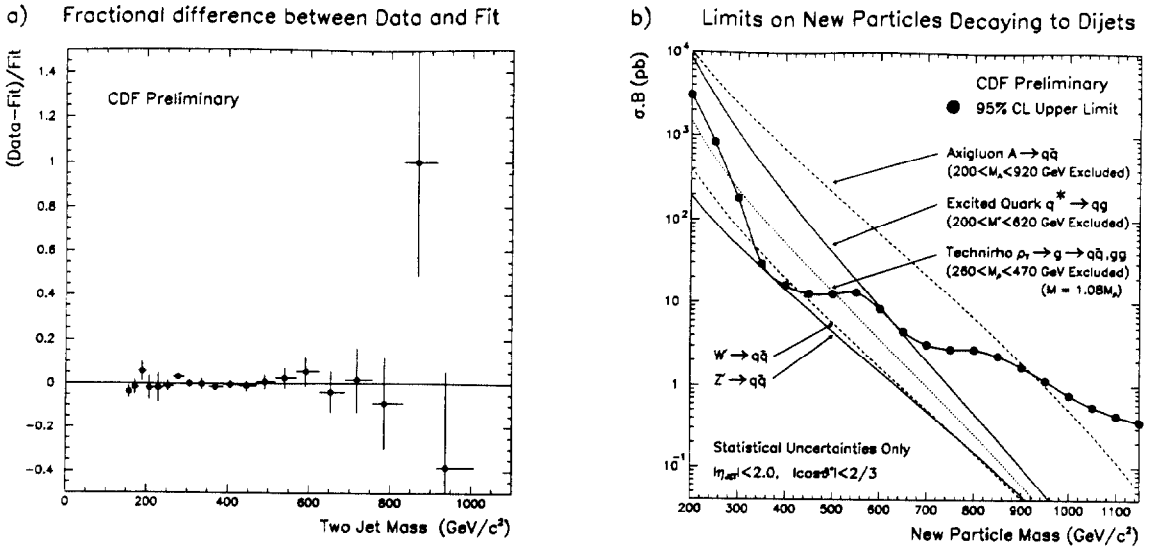


Fig. 2. a) Dijet mass data compared to fit. b) Cross section limits on new particles.

2. Data

Using four triggers from the CDF 1992-93 run, we combine dijet mass spectra above a mass of 150 GeV/c^2, 241 GeV/c^2, 265 GeV/c^2, and 353 GeV/c^2 with integrated luminosities of .038 pb^{-1}, .66 pb^{-1}, 3.2 pb^{-1}, and 19.1 pb^{-1} respectively. Jets are defined with a fixed cone clustering algorithm (R=0.7) and then corrected for detector response, energy lost outside the cone, and underlying event. We take the two highest P_T jets and require that they have pseudorapidity $|\eta| < 2$ and a CMS scattering angle $\cos\theta^* = \tanh[(\eta_1 - \eta_2)/2] < 2/3$. The $\cos\theta^*$ cut provides uniform acceptance as a function of mass and reduces the QCD background which peaks at $\cos\theta^* = 1$. In Fig. 1b the dijet mass distribution is presented as a differential cross section in bins of the mass resolution ($\sigma \sim 10\%$).

3. Dijet Mass Search

Figure 1b shows the data and a fit to a smooth function of three parameters[1]; Fig. 2a shows the fractional difference between the data and the fit ($\chi^2/DF = .96$). There is no statistically significant evidence for a new particle. For narrow resonances it is sufficient to determine the mass resolution for only one type of new particle because the detector resolution dominates the width. In Fig. 1b we show the mass resolution for excited quarks (q*) from PYTHIA plus a CDF detector simulation; the long tail at low mass comes from gluon radiation. We perform a binned maximum likelihood fit of the data to the background parameterization[1] and the mass resonance hypothesis (q* in Fig. 1b) and obtain a 95% confidence level upper limit on the cross section for new particles as a function of mass. In Figure 2b, we compare this upper limit to the cross section for axigluons,[2] excited quarks,[3] technirhos,[4] and new gauge bosons (W′ and Z′). The calculations are lowest order[5] using CTEQ2L[6] parton distributions and one-loop $\alpha_s(m^2)$ and require $|\eta| < 2$ and $\cos\theta^* < 2/3$. We exclude new particles in mass regions for which the theory lies above our limit in Fig. 2b; for technirhos this excludes the

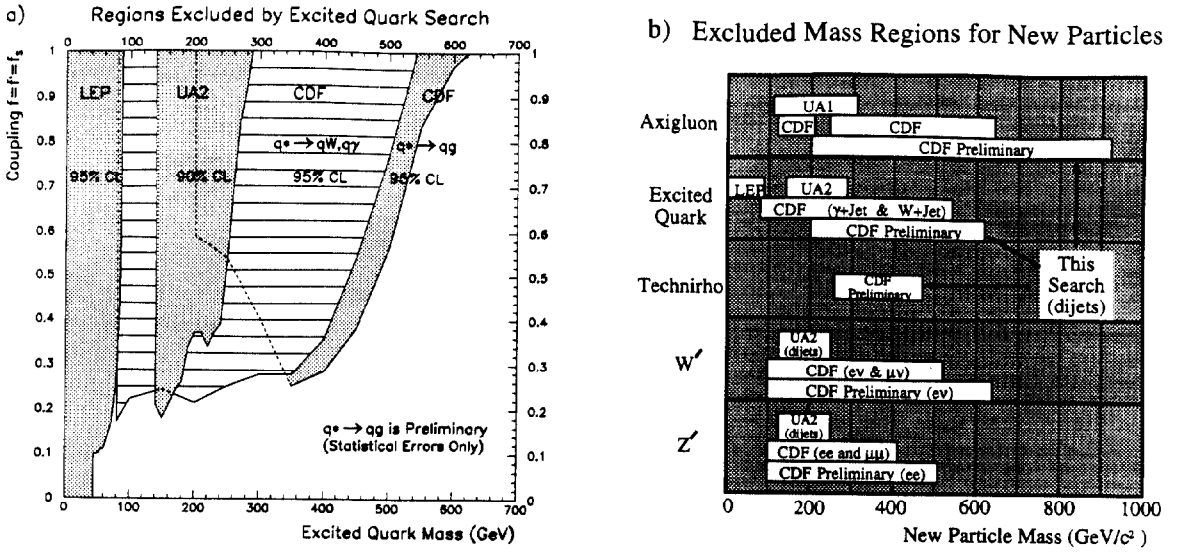


Fig. 3. a) Limits on coupling vs. mass for excited quarks. b) Limits on new particles.

dijet mass which is related to the true technirho mass by $M \approx 1.08 M_\rho$ because of the indirect nature of the production/decay process ($q\bar{q}, gg \rightarrow g \rightarrow \rho_T$). The legend in Fig. 2b quotes limits on true masses which are repeated below.

4. Conclusions

The measured dijet mass spectrum is a smoothly falling distribution within statistics. This preliminary search excludes at 95% CL a model of axigluons[2] for $200 < M_A < 920$ GeV/c^2, a model of excited quarks[3] for $200 < M_{q^*} < 620$ GeV/c^2, and a model of technirhos[4] for $260 < M_{\rho_T} < 470$ GeV/c^2. The cross section for new gauge bosons is too small to exclude with confidence. These preliminary limits include statistical uncertainties only; systematic uncertainties should reduce the limit by roughly 20-40 GeV/c^2. For excited quarks we show in Fig. 3a the excluded regions in the coupling vs. mass plane compared to previously published results.[7] In Fig. 3b all our results are summarized and compared to previously published results and CDF preliminary results, illustrating that dijets allow us to significantly extend the search for new particles.

References

1. QCD based function: $d\sigma/dm = A(1 - m/\sqrt{s})^N/m^P$ with parameters A, N and P.
2. Bagger, Schmidt & King PRD37(1988)1188 with axigluon decays to known quarks.
3. Baur, Hinchliffe & Zeppenfeld Int. J. Mod. Phys A2(1987)1285; Baur, Spira & Zerwas Phys. Rev. D42(1990)815.
4. Lane & Ramana, PRD44(1991)2678; Eichten & Lane, Phys. Lett. B327(1994)129: model on page 132 where the ρ_T is mass degenerate and decays to dijets only.
5. For new gauge boson we multiply by a K-factor to account for higher order terms.
6. J. Botts et al. (CTEQ Collaboration) Phys. Lett. B304(1993)159.
7. F. Abe et al. (CDF Collaboration), Phys. Rev. Lett. 72(1994)3004.